

Development of RRSC population models for use within the USFWS Strategic Habitat Conservation Framework: *Mechanistic Home Range Models*

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Project Goals

- 1 Use NASA Earth Science products to develop an understanding of the impacts of environmental change on species populations as well as the habitats and ecological functions that support them.
- 2 Integrate these products and predictive species models into the DSS of the USFWS and other agencies.



- Use species as “sentinels” to sample the landscape.
- Produce *spatially-explicit* population models.

Risk Reward Spatial Capacity (RRSC) models:

- Species must survive environmental risks and utilize resources to successfully reproduce.
- This balance occurs on spatially heterogeneous “landscapes” that are temporally dynamic.

RRSC models acknowledge that the behavior of individual animals and the demographic rates of populations respond to these spatio-temporal landscapes and use these relationships to make predictions about the distribution and abundance of species.

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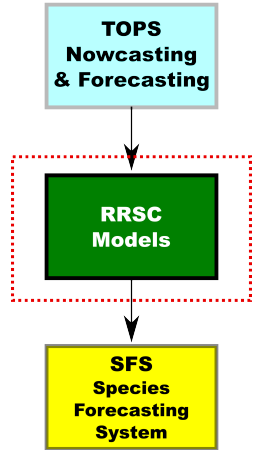
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Objectives

- 1 Measure, monitor, and analyze the ecological conditions of focal regions.
- 2 Implement a modeling framework based on population and movement data of focal species.
- 3 Establish a Species Forecasting System (SFS) within a PC-based, ArcGIS environment that allows end-users to develop appropriate spatio-temporal covariates and run RRSC models.

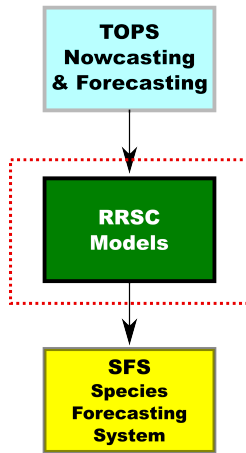
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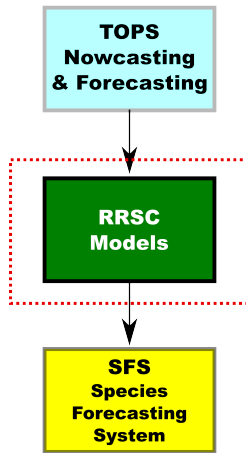
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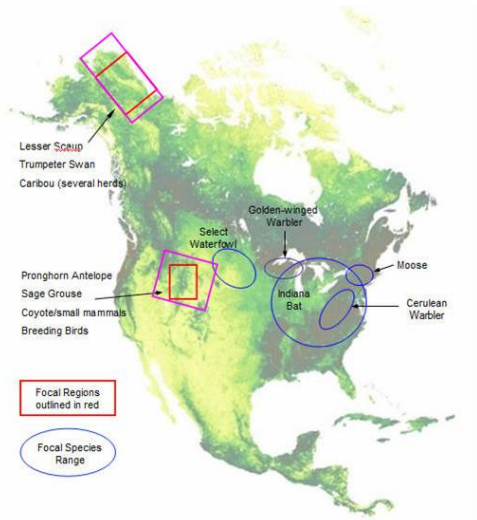
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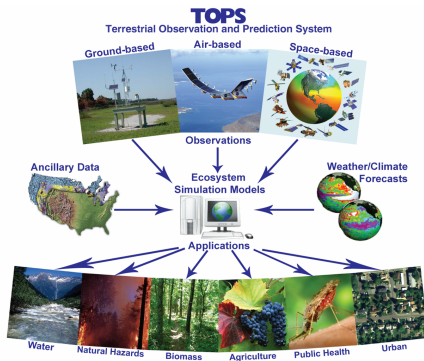
Focal Regions

- Northern Alaska
 - Lesser scaup
 - Caribou
- Northern Rockies
 - EU (coyote, wolf, red fox, small-mamms)
 - Pronghorn
 - Sage grouse
 - Breeding birds
- Other North American regions



Covariates

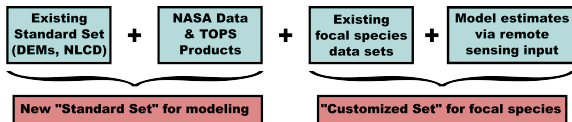
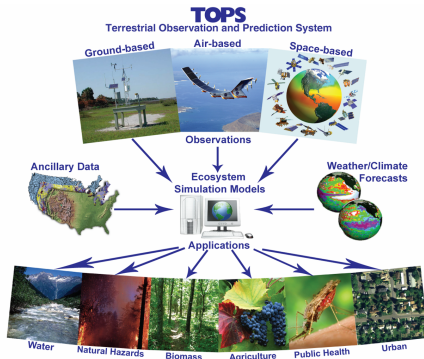
- Monitoring
- Modeling
- Forecasting
- Multiple Scales



Establish methods to incorporate existing geospatial data and products from the NASA-sponsored TOPS program into the USFWS DSS and SHC framework.

Covariates

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Basic types of RRSC models:

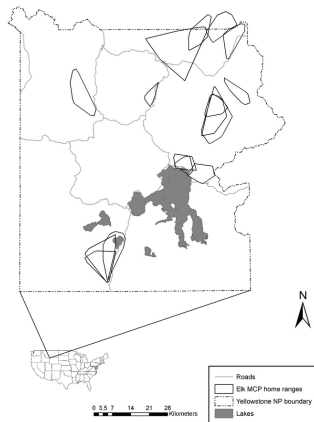
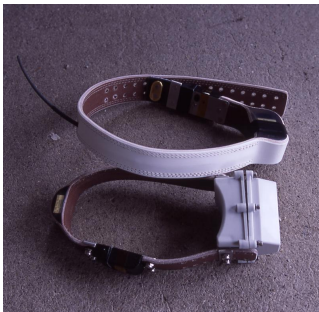
1) Resource Selection Analysis – Habitat Models

- RSPF - Resource Selection Probability Functions (independent locations)
- MHRM - Mechanistic Home Range Models (dependent path movement)

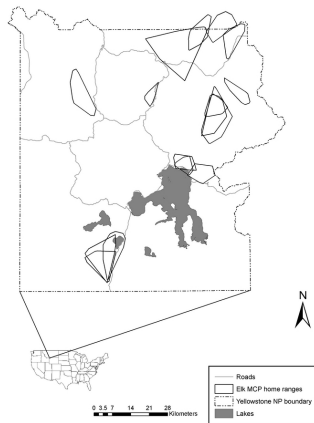
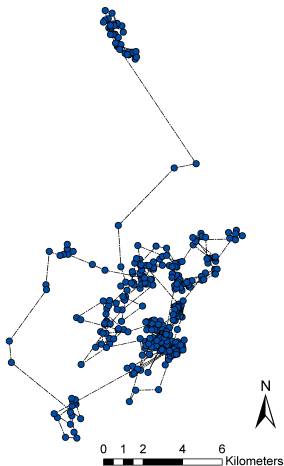
2) Population Demographic Models

- Abundance (population time series analysis)
- Recruitment (GLM approaches)
- Survival/mortality (GLM approaches)
- Dispersal (GLM approaches)

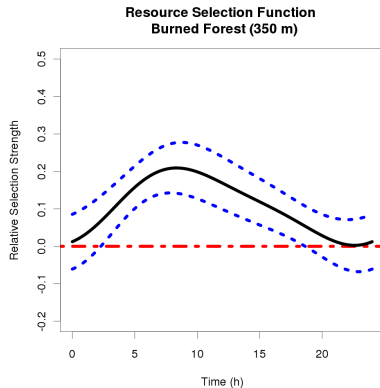
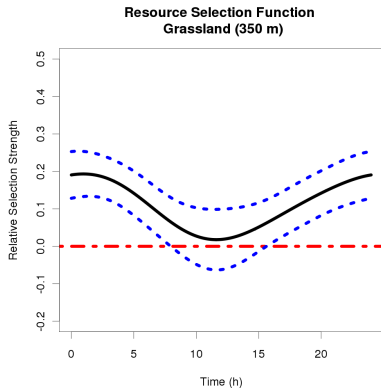
Collect animal location data



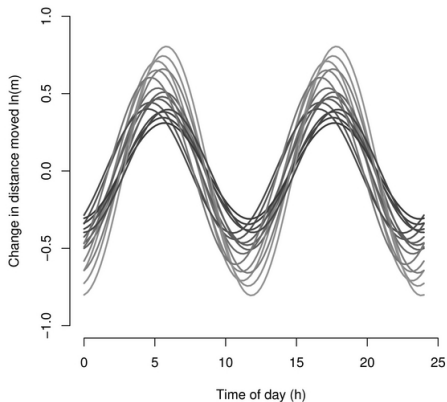
Animals exhibit complex movement patterns.



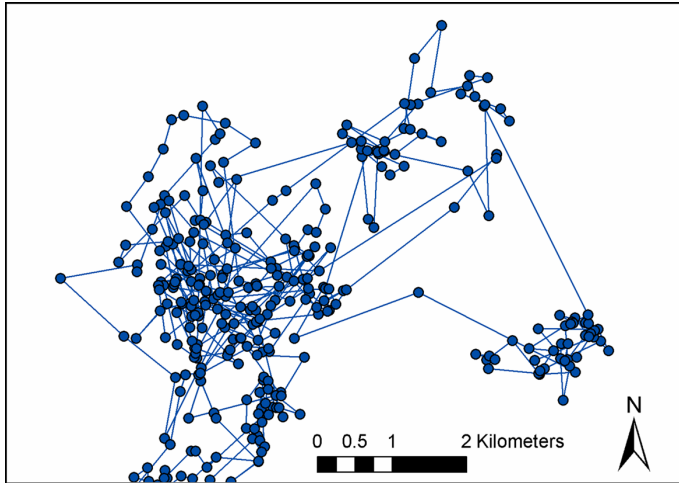
Temporally variable habitat selection.



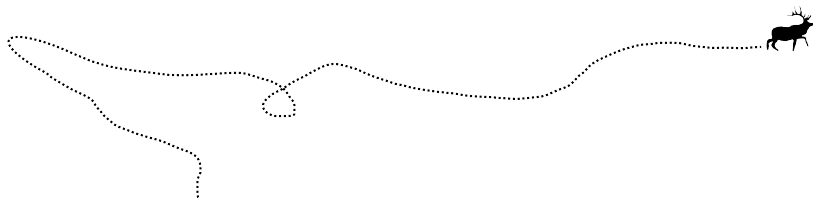
Temporally variable activity patterns.



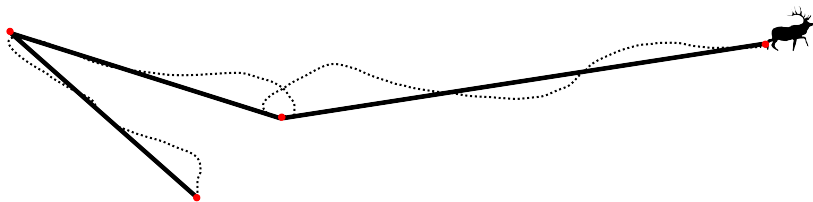
Mechanistic movement models are needed



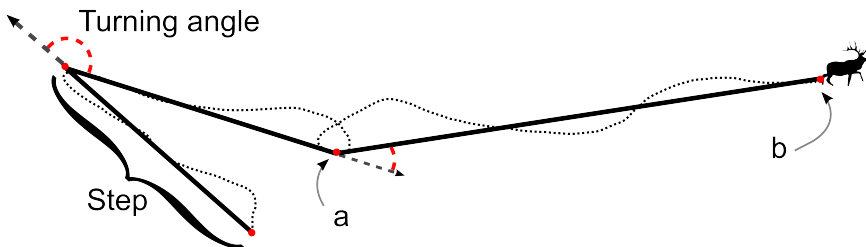
Continuous movement path



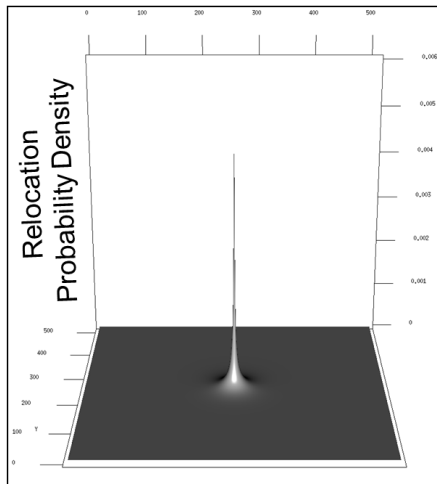
Subset of locations



Discrete steps



Redistribution Kernel



A mechanistic model of animal movement.



$$Pr(a \text{ to } b) = \frac{\phi(a_0, a, b; \theta) \omega\{\mathbf{Z}(b); \beta\}}{\int_{c \in D_a} \phi(a_0, a, c; \theta) \omega\{\mathbf{Z}(c); \beta\} dc}$$

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Question:

- How do we turn a movement model into a Utilization Distribution for animals that do not have biologically meaningful home range centers?

Modeling the Home Range

$$Pr(a \text{ to } b) = \frac{\phi(a_0, a, b; \theta) \omega\{\mathbf{Z}(b); \beta\}}{\int_{c \in D_a} \phi(a_0, a, c; \theta) \omega\{\mathbf{Z}(c); \beta\} dc}$$

- 1 Add memory to the model.
 - $\phi(\cdot)$ will affect broad-scale bias in movement.
 - $\omega(\cdot)$ will affect fine-scale selection.
- 2 Iterate relocation kernel through time until stable home range develops.

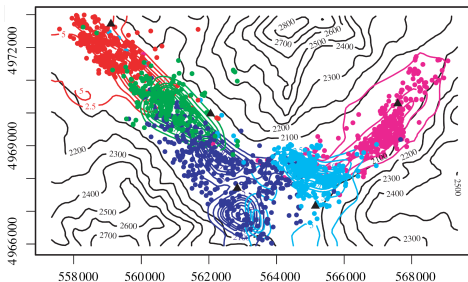
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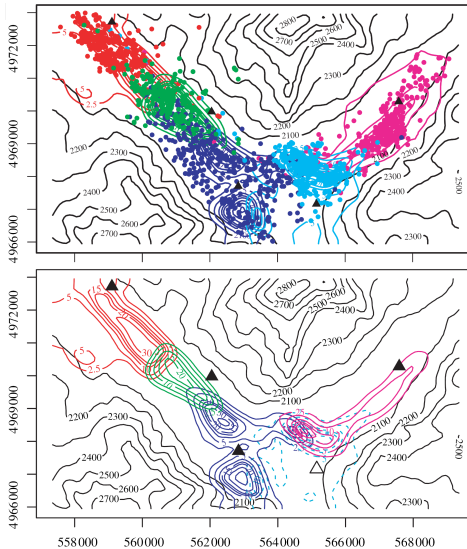
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Memory with habitat selection:

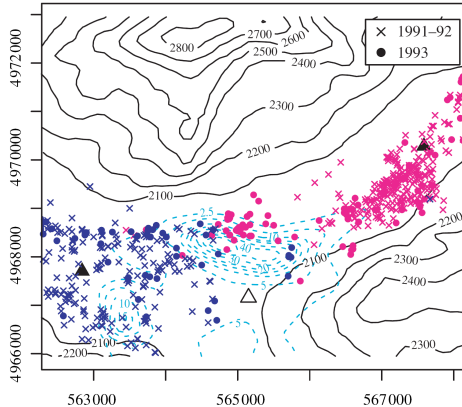
Coyotes in Yellowstone



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Ongoing Research

- 1 Incorporate TOPS data products.
- 2 Fit models to real elk data.
- 3 Compare multiple model structures.
- 4 Test predictive ability of models.
- 5 Expand to other species.



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